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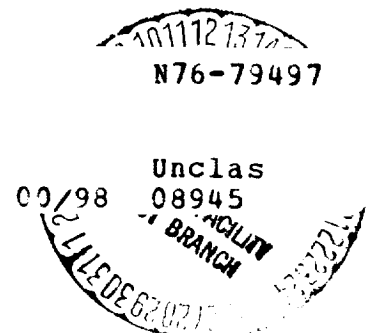
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An Investigation of Handling Qualities of Sailplanes

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Summary

A most successful sailplane handling qualities flight test session was held May 1 through May 7, 1976. A round-robin schedule was used for seven pilots to evaluate 6 sailplanes. A questionnaire was used to evaluate a wide range of sailplane handling characteristics using a Cooper-Harper rating scale. 90 flights comprising 87 hours flying time were made during the flight session. The pilot rating and their comments have been converted into a data set for analysis and presentation.

The development of a data acquisition system suitable for sailplanes has been a part of this study. An 8 channel, battery powered data logger is being constructed after successful stick position measurements on the Schweizer 2-32 were made using a prototype system. The unit under construction can be easily modified to become a 300-400 sample/sec. data acquisition system suitable for dynamic stability and control measurements.

An analytic analysis of the stability and control characteristics of sailplanes used in the flight test evaluation is being made to permit correlation with pilot ratings.

Introduction

The handling qualities of high performance sailplanes, especially the longitudinal characteristics, have been an area of concern for certification. It was proposed that an evaluation session be held at MSU to acquire pilot opinion data for a set of sailplanes which represent the range of handling qualities of interest. It was proposed that test pilots from FAA, NASA, and the soaring community participate to determine the variability of pilot response to the sailplane handling qualities and to give the research and certification groups insights into the utilization of sailplanes.

The soaring community was most cooperative in the loaning of equipment for the flight test session. The session was held May 1 through May 7, 1976, with perfect weather. The session was executed smoothly with no problems.

Instrumentation was developed for measurement of stick position and stick force. It was found that more development was required to have a truly useful data acquisition system for sailplanes.

During the summer the pilot ratings and comments were converted into a computer data base for further analysis. Analytical estimates were made of the stability and control parameters of the sailplanes flown. The 2-32 was flown over a wide c.s. range to provide experimental verification of analytical estimates.

It was found that sufficient funds remained at the end of the six month contract period to extend for 6 more months. This extension allowed further analysis of the pilot data and further development of data acquisition systems for sailplanes.

Sailplane Handling Qualities Evaluation Flight Test Session

The flight tests were conducted from May 1 through May 7 at the Raspet Flight Research Laboratory. This facility includes a large, modern hangar with fabrication, radio and instrumentation shops, and is located adjacent to the Starkville municipal airport. The latter consists of a 5,000 feet long hard surface runway.

The following seven evaluation pilots participated in the flight tests:

1. B. Carris - SSA pilot, also Schweizer Aircraft Corporation, chief pilot.
2. E. K. Enevoldson - NASA-DRFC Aerospace Research Pilot
3. J. Gera - NASA grant technical monitor
4. N. J. Glenn - Flight Test Pilot, FAA Eastern Region
5. R. M. Gough - Flight Test Specialist Pilot, FAA, Washington, D.C.
6. M. S. Griffith - SAA pilot, also captain, Braniff Airlines
7. J. M. Patton - NASA-Langley Aerospace Research Pilot

The tests were conducted under the direction of the grant principal investigator, Professor George Bennett and the RFRL test pilot, Mr. Howard Ebersole.

The following sailplanes, which had been loaned to MSU by their owners, were evaluated:

Schweizer SGS 2-32 (N99859)

Schleicher Ka-6BR (N37B)

Schweizer SGS 1-35 (N135SA)

Schempp-Hirth Standard Cirrus (N136)

Glasflugel H301 Libelle (N1615)

Schempp-Hirth Nimbus II (N173)

All six machines had standard U. S. Government Approved Type Certificates. Four of the sailplanes were manufactured in Germany; the remaining two machines were built by the Schweizer Aircraft Corporation. No special equipment, other than a sensitive helicopter airspeed indicator, was added to the normal instrument panel for the flight test session. The airspeed system, however, was calibrated using a trailing static source before the pilots arrived at RFRL.

Evaluation flights began on the morning of May 2 and continued through May 6 in generally excellent weather conditions. During the five days, over ninety evaluation flights were made. The duration of each flight was about 45 minutes. No equipment malfunctions were encountered during the five days either in the sailplanes or the two towplanes. Each pilot was given a list of maneuvers which were selected to bring out any unsafe characteristics of the sailplanes, and to allow an assessment of flying qualities in all flight segments from takeoff to landing. The flights were made from tow release altitudes between eight and ten thousand feet. The duration of towed flight to these altitudes was less than ten minutes. Each pilot was given the opportunity to fly the evaluation maneuvers in both smooth and rough air and to take as many flights as he required to fill out an evaluation form on each sailplane type. On every flight cassette tape recorders were taken along for comments. The pilots were asked to summarize their comments on the seven page long evaluation form, and to give a rating on each flight phase using the Cooper-Harper scale. Two of the sailplanes had instrumentation suitable to obtain stick position and force as a function of airspeed.

Pilot Rating Data Analysis

The pilot rating questionnaire covered all facets of the sailplane flight envelope. A total of 74 topics were rated, accompanied by pilot comments. Since a large quantity of data was obtained, a computer program was written to simplify the manipulation and presentation of the data. This task has been accomplished, and now analysis of significance is underway.

It was found that the very light stick forces of some sailplanes were objectionable. There is a wide range of ratings which is being treated with a follow-on questionnaire to obtain more background data on the pilot's attitudes.

Estimates of the stability and control parameters of the sailplanes are being made to allow correlation with pilot opinion. Stick position data obtained during flight test of 2-32 shows good correlation of experimental and theoretical estimates of stick fixed neutral points.

Instrumentation

One of the objectives of the handling quality study was to make measurements of stick position and stick force of the sailplane set. Small, low cost, battery powered, data acquisition systems are not available. The initial design concept was to give the pilot a digital display, but it was found that transcribing the value to tape or to the knee pad was difficult. A prototype data logger was put together using a small printer. This unit worked very well and immediately plans were made to put together an eight channel multiplexed unit with sample-and-hold on all channels. Signal conditioning cards for position pots and bridge circuits have been constructed. The printer is being used initially, but the unit is compatible with a low cost cassette digital recorder which will allow 200-400 samples/sec recording rate.